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Highlighted in this Issue: PESTICIDES

Contents

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Summary

Due mainly to a possible 11- to 17-percent rise in field crop acreage next year, U.S. farmers are expected to spend 15 to 20 percent more than in 1983 for pesticides, fertilizers, farm machinery (including repairs), and energy. Next year, farm outlays for these four inputs should amount to about $40 billion. Typically, these items account for around one-third of total expenditures for crop and livestock production.

Farm demand for pesticides, especially herbicides, will climb substantially next year, as row-crop acreage is expected to rebound from 1983's PIK-reduced level to about the level planted in 1982. While pesticide production may be down slightly in 1984, supplies should be adequate because of large inventory carryovers from the 1983 crop season. Prices likely will rise only about 1 percent. Total farm expenditures for pesticides are projected between $3.5 and $4 billion, up from $3 billion in 1983.

In 1982, U.S. farmers applied about 550 million pounds (active ingredients) of pesticides on 13 major field and forage crops in 33 States that accounted for 80 percent of the acreage planted to those crops. Herbicide use totaled some 450 million pounds, and insecticide use amounted to 70 million. Corn production accounted for the major share of herbicide use with about 245 million pounds, followed by soybean production at 125 million. Corn also accounted for the most insecticides, 30 million pounds, while cotton used 17 million.

Total pounds of herbicide active ingredients applied to major field and forage crops rose 21 percent between 1976 and 1982. Total insecticide use, however, fell about 45 percent, due largely to increasing use of recently introduced synthetic pyrethroids on cotton. Synthetic pyrethroids are applied at an average of 10 percent or less the rate of traditional cotton insecticides.

U.S. fertilizer use will rebound next season in response to higher crop prices and expanded acreage. Total use could be up about a fifth from 1983, as some two-thirds to three-fourths of the more than 70 million acres in acreage reduction programs this year could come back into production. A sharp rise in corn acreage will help reverse a 2-year decline in fertilizer use on that crop and boost total use as well. After holding steady or declining for 2 years, overall fertilizer prices are expected to increase to 1981/82 levels, with nitrogen advancing the most.

Domestic production of nitrogen fertilizer could increase 10 percent and phosphate output could rise 8 percent in 1984. Potash production could remain close to year-earlier levels, as imports advance 15 to 20 percent. Nitrogen imports could also climb about 15 percent. Because of stepped-up use and higher domestic prices, U.S. producers are likely to reduce nitrogen exports from year-earlier levels. In contrast, U.S. phosphate exports may increase about 10 percent.

Farm machinery sales are likely to improve in 1984, with several forecasters indicating a 10- to 15-percent gain in unit sales. The projected increase assumes favorable commodity prices, a return to more normal weather, moderating interest rates, and a substantial gain in planted acreage. Despite early signs that sales would pick up in 1983, widespread drought in the Corn Belt and South caused January-August sales to slip about 12-15 percent from a year earlier.

Energy supplies for the agricultural sector are expected to be adequate in 1984. Gasoline, diesel fuel, LP gas, and fuel oil prices are likely to be about the same as in 1983. Natural gas prices, however, may be up as much as 16 percent—due to the ongoing partial decontrol of prices at the wellhead.

PESTICIDES

Demand

U.S. farm demand for pesticides in 1984 is expected to be up substantially from 1983. Field crop acreage is projected to increase 11 to 17 percent from last year's PIK-reduced acreage, back to levels planted in 1982 (table 1). Corn acreage is expected to increase 37 to 43 percent and cotton acreage 33 to 43 percent. Wheat acreage may remain constant or increase up to 5 percent from 1983 levels. Rice acreage should rise back to 1982 levels, while barley and oats acreage is projected to decrease 20 to 26 percent in 1984.

With greater crop acreages expected to be planted in 1984, the demand for herbicides will increase. In 1982, farmers treated 91 percent of their row crop acreage with 408 million pounds (active ingredients, a.i.) of herbicides (table 2). For small grain crops, 38 million pounds (a.i.) were used on 44 percent of the acreage. U.S. herbicide supplies are expected to exceed 600 million pounds (a.i.) in 1984 (table 3).

Insecticide use varies with the extent and intensity of insect infestations. If 1984 infestations are similar to those in 1982, field and forage crop farmers will apply about 71 million pounds (a.i.) of insecticides to their crops next season (table 4). U.S. insecticide supplies are estimated at 215 million pounds (a.i.) for 1984 (table 3).

Fungicide use in 1982 totaled 6.6 million pounds (a.i.) on the major field and forage crops (table 5). If planted crop acreages return to 1982 levels next season, fungicide supplies will be more than adequate to meet the expected demand (table 3).

Supplies

Total pesticide supplies available for domestic use (not including imports) in 1984 are projected to be down 2 percent from 1983 (table 3). Production is expected to be down 10 percent, but the inventory carryover for 1984 is 26 percent greater than the 1983 carryover. Total herbicide supplies in 1984 should decrease 6 percent, while insecticide and fungicide supplies are projected to rise 7 and 6 percent, respectively, from last season.

Table 1.—Actual and projected U.S. planted field crop acreages

Crop	Planted acres		Percentage change	
	1982	1983	1982-83[1]	Projected 1983-84
	Million		*Percent*	
Row crops:				
Corn	81.9	60.1	-27	37 - 43
Soybeans	72.2	63.3	-11	11 - 17
Cotton	11.4	8.3	-27	33 - 43
Grain sorghum	16.1	11.6	-28	34 - 42
Peanuts	1.3	1.4	5	-1 - 1
Tobacco (harvested)	0.9	0.8	-12	0 - 5
Total	183.8	145.5	-20	22 - 30
Small grain crops:				
Rice	3.3	2.3	-29	35 - 45
Wheat	87.3	76.6	-12	0 - 5
Barley and oats	23.8	30.8	29	-26 - -20
Total	114.4	109.7	-7	-7 - -1
Total	298.2	255.2	-14	11 - 17

[1]Percentage changes computed on the basis of actual acreages rather than on the rounded figures presented here.

Sources: (5, 14).

Table 2.—Farm herbicide use by crop, 1971, 1976, and 1982

Crop	Quantity (active ingredients)			Proportion of acres treated		
	1971	1976	1982	1971	1976	1982
	Million pounds			*Percent*		
Row crops:						
Corn	101.1	207.1	243.4	79	90	95
Soybeans	36.5	81.1	125.2	68	88	93
Cotton	19.6	18.3	17.3	82	84	97
Grain sorghum	11.5	15.7	15.3	46	51	59
Peanuts	4.4	3.4	4.9	92	93	93
Tobacco	0.2	1.2	1.5	7	55	71
Total	173.3	326.8	407.6	71	84	91
Small grain crops:						
Rice	8.0	8.5	13.9	95	83	98
Wheat	11.6	21.9	18.0	41	38	42
Other[1]	5.4	5.5	5.9	31	35	45
Total	25.0	35.9	37.8	38	38	44
Forage crops:						
Alfalfa	0.6	1.6	0.3	1	3	1
Other hay[2]	(2)	(2)	0.7	(2)	(2)	3
Pasture and range	8.3	9.6	5.0	1	1	1
Total	8.9	11.2	6.0	1	1	1
Total	207.2	373.9	451.4	17	22	33

[1]Includes barley, oats, and rye in 1971 and 1976 and barley and oats in 1982. [2]Included in the alfalfa figure.

Sources: (8, 9, 10, 11).

Herbicide production is expected to be 18 percent below 1983's output. This will be offset to a large extent by a 32-percent increase in herbicide inventory carryovers from 1983. Herbicide exports are expected to increase 5 percent from 1983 levels.

Insecticide production in 1984 is anticipated to be 10 percent above a year earlier. In addition, the inventory carryover for 1984 increased 9 percent. Insecticide exports are likely to increase 17 percent from 1983 levels.

Fungicide supplies are projected to increase 6 percent from 1983 levels. Although production is expected to rise 2 percent, 1984 exports are also expected to increase 6 percent. Fungicide inventories carried into the 1984 season are 23 percent higher than stocks at the start of the 1983 season.

With substantial plant capacity increases in the mid- and late-70's and depressed demand, pesticide production facilities are operating at low utilization rates and little production expansion is taking place. For all pesticide production, the capacity utilization rate averaged 54 percent in 1983, and is expected to drop to 47 percent in 1984 (table 6). This compares with average rates of 80 to 86 percent in the mid- and late-70's.

Herbicide producers operated at 66 percent of capacity in 1983 and are expected to operate at only 54 percent in 1984. Insecticide producers are projected to operate at just over one-third of capacity—about the same as in 1983, and about half the average 1981-82 rate. Fungicide production is expected to increase slightly to 76 percent of capacity in 1984.

Table 3.—Pesticide production, inventories, exports, and net supplies, 1983 and projected 1984

Item	Quantity (active ingredients)[1]		Projected change from 1983 to 1984
	1983	Projected 1984	
	Million pounds		*Percent*
Herbicides:			
Production	549	450	−18
Inventory carryover from previous year	212	280	32
Exports	116	122	5
Net domestic supply	645	608	−6
Insecticides:			
Production	188	206	10
Inventory carryover from previous year	79	86	9
Exports	66	77	17
Net domestic supply	201	215	7
Fungicides:			
Production	53	54	2
Inventory carryover from previous year	13	16	23
Exports	18	19	6
Net domestic supply	48	51	6
All pesticides:			
Production	790	709	−10
Inventory carryover from previous year	304	382	26
Exports	200	218	9
Net domestic supply	894	874	−2

[1]Production for surveyed producers only. These firms produce a major portion of all U.S. farm pesticides.

Source: Survey of basic pesticide producers in September 1983.

Table 4.—Farm insecticide use by crop, 1971, 1976, and 1982

Crop	Quantity (active ingredients)			Proportion of acres treated		
	1971	1976	1982	1971	1976	1982
	Million pounds			*Percent*		
Row crops:						
Corn	25.5	32.0	30.1	35	38	37
Soybeans	5.6	7.9	10.9	8	7	12
Cotton	73.4	64.1	16.9	61	60	36
Grain sorghum	5.7	4.6	2.5	39	27	26
Peanuts	6.0	2.4	1.0	87	55	48
Tobacco	4.0	3.3	3.5	77	76	85
Total	120.2	114.3	64.9	31	29	26
Small grain crops:						
Rice	0.9	0.5	0.6	35	11	16
Wheat	1.7	7.2	2.4	7	14	3
Other[1]	0.8	1.8	0.2	3	5	1
Total	3.4	9.5	3.2	6	12	3
Forage crops:						
Alfalfa	2.5	6.4	2.5	8	13	7
Other hay	(2)	(2)	0.1	(2)	(2)	**
Pasture and range	0.2	0.1	*	0	**	**
Total	2.7	6.5	2.6	**	1	**
Total	126.3	130.3	70.7	6	9	8

* = Less than 50,000 pounds (a.i.).

** = Less than 1 percent.

[1]Includes barley, oats, and rye in 1971 and 1976 and barley and oats in 1982. [2]Quantity of insecticides applied to other hay is included in the alfalfa figure.

Sources: (8, 9, 10, 11).

Table 5.—Major field and forage crop pesticide use, 1971, 1976, and 1982

Pesticide	1971 Pounds (a.i.)	1971 Share of total	1976 Pounds (a.i.)	1976 Share of total	1982[1] Pounds (a.i.)	1982[1] Share of total
	Million	*Percent*	*Million*	*Percent*	*Million*	*Percent*
Herbicides:						
Alachlor	14.0	6.8	88.5	23.7	84.6	18.7
Atrazine	53.9	26.0	90.3	24.1	76.0	16.8
Butylate+	5.6	2.7	24.4	6.5	54.9	12.2
EPTC+	3.4	1.6	8.6	2.3	8.3	1.8
Linuron	1.7	0.8	8.4	2.2	6.4	1.4
Metolachlor	—	—	—	—	37.0	4.8
Propachlor	22.3	10.8	11.0	2.9	7.8	1.7
2,4-D	30.5	14.7	38.4	10.3	23.3	5.2
Trifluralin	10.3	5.0	28.3	7.6	36.1	8.0
All materials	207.2	[2](68.4)	373.9	(79.6)	451.3	(74.1)
Insecticides:						
Carbaryl	11.2	8.9	9.3	7.1	2.3	3.3
Carbofuran	2.8	2.2	11.6	8.9	7.3	10.3
Chlordimeform	—	—	4.5	3.4	0.7	1.0
Chlorpyrifos	*	*	*	*	5.1	7.2
DDT	13.5	10.7	—	—	—	—
EPN	0.9	0.7	6.2	4.8	1.4	2.0
Ethoprop	0.6	0.5	1.1	0.8	2.2	3.1
Fonofos	0.6	0.5	5.0	3.8	5.2	7.4
Methomyl	0.3	0.2	2.5	1.9	1.7	2.4
Methyl parathion	27.1	21.5	22.8	17.5	10.7	15.1
Parathion	7.0	5.5	6.6	5.1	4.2	5.9
Phorate	3.6	2.9	6.3	4.9	4.0	5.7
Synthetic pyrethroids	—	—	—	—	2.6	3.7
Terbufos	—	—	2.5	1.9	8.7	12.3
Toxaphene	31.9	25.2	30.7	23.5	5.9	8.3
All materials	126.3	(78.8)	130.3	(83.7)	70.7	(87.7)
Desiccants and defoliants	17.4		8.6		9.4	
Fumigants	9.1		19.4		[3]7.9	
Fungicides	6.4		8.1		6.6	
Growth regulators	5.0		6.3		6.0	
Miticides	1.1		1.0		0.3	
Other	32.5		35.3		—	
Total	405.0		582.9		552.3	

— = None reported.

* = Less than 50,000 pounds (a.i.).

[1]See figure 1: 33 States (excluding California). [2]Numbers in parentheses represent the shares of the total pounds (a.i.) of the materials listed individually. [3]Does not include tobacco plantbed applications.

Sources: (9, 10, 11).

Table 6.—Pesticide facility utilization rates for 1975-83 and projected 1984

Year	Production as a proportion of capacity: Herbicides	Insecticides	Fungicides	All pesticides
	Percent			
1975	92	74	93	84
1976	91	85	82	86
1977	85	76	77	80
1978	81	87	83	83
1979	74	85	84	80
1980	77	79	84	78
1981	74	72	68	73
1982	84	68	70	80
1983	66	33	71	54
1984	54	35	76	47

Sources: (4, 6, 7, 12) and survey of basic pesticide producers in September 1983.

Table 7.—Pesticide facility expansion from 1975 to 1983 and projected 1983-84

Year	Herbicides	Insecticides	Fungicides	All pesticides
	Percent			
1975-76	19	2	0	12
1976-77	23	8	12	16
1977-78	3	4	3	3
1978-79	4	3	11	4
1979-80	2	1	3	2
1980-81	3	0	0	2
1981-82	4	7	0	5
1982-83	*	*	NA	*
1983-84	0	6	0	1

* = Less than 1 percent.

NA = Not available.

Sources: (4, 6, 7, 12) and survey of basic pesticide producers in September 1983.

Due to substantial excess capacity and low operating rates, little new plant capacity is expected to come on stream in 1984. No new herbicide or fungicide production capacity is planned for 1984, but expansion of insecticide facilities should increase total capacity about 6 percent (table 7).

Exports are expected to account for 31 percent of the expected 1984 pesticide production, up from 25 percent in 1983 (table 3). About 27 percent of the herbicides, 37 percent of the insecticides, and 35 percent of the fungicides to be produced in 1984 are intended for the export market.

While pesticide producers surveyed in September 1983 indicated that inventories have continued to rise, distributors reported that they were able to keep pesticide inventories in line by purchasing judiciously from producers and moving excess stocks with attractive sales promotions.

Prices and Expenditures

Pesticide prices quoted by manufacturers for next year are expected to be up about 1 percent from 1983 (table 8). This compares with essentially no change in pesticide prices at the farm level during the 1983 season. Last season's farm price changes, however, ranged from an 8-percent rise for insecticides to a 4-percent drop for herbicides. The continuing decline in the price of atrazine and a substantial cut in the price of trifluralin were major factors in the overall herbicide price decline last season. Atrazine prices are again expected to be down slightly in 1984.

After climbing steadily throughout the 1970's, pesticide expenditures leveled off at $3.5 billion in 1982 and dropped about 15 percent to $3 billion in 1983 due to the PIK program (table 9). This trend also reflects a stabilizing pesticide demand and a small overall price increase. During the 1970's, pesticide prices rose substantially less than prices for other farm inputs, as reflected by a decline in pesticide expenditures in terms of real dollars.

Use

Pesticide use data were obtained from USDA's 1982 Crop and Livestock Pesticide Usage Survey. A total of 6,520 farmers were interviewed in 33 States (figure 1), where 80 percent of the total U.S. crop acreage planted to the 13 surveyed crops was located (table 10). In 1976, the 13 crops accounted for 85 percent of the total U.S. farm pesticide use. The proportion of planted acres surveyed in 1982 ranged from 97 percent for row crops to 71 percent for forage crops. California was not included in the survey, which is why only 88 percent of all cotton acreage and 82 percent of all rice acreage was surveyed.

Herbicides

U.S. farmers used 451 million pounds (a.i.) of herbicides on the major field and forage crops in 1982, up 21 percent from 1976 when 374 million pounds were applied (table 2). The proportion of field and forage crop acres treated with herbicides increased from 22 percent in 1976 to 33 percent in 1982. In 1982, farmers used about

Table 8.—Pesticide price changes in 1982-83 and projected 1983-84

Item	1982-83[1]	Projected 1983-84[2]
	Percent	
Herbicides	−4	*
Insecticides	8	1
Fungicides	3	*
All pesticides	0	1

* = Less than 1 percent.

[1]Weighted average prices paid by farmers. [2]Quoted manufacturer prices.

Sources: (13) and survey of basic pesticide producers in September 1983.

Table 9.—Pesticide expenditures, 1973 to 1983

Year	Nominal	Real (1967=100)
	Billion dollars	
1973	1.2	1.0
1974	1.5	1.2
1975	2.2	1.4
1976	1.9	1.1
1977	2.0	1.1
1978	2.4	1.2
1979	3.1	1.5
1980	3.1	1.2
1981	3.5	1.2
1982	3.5	1.2
1983[1]	3.0	1.0

[1]Preliminary estimates.

Sources: (3) and survey of basic pesticide producers and distributors in September 1983.

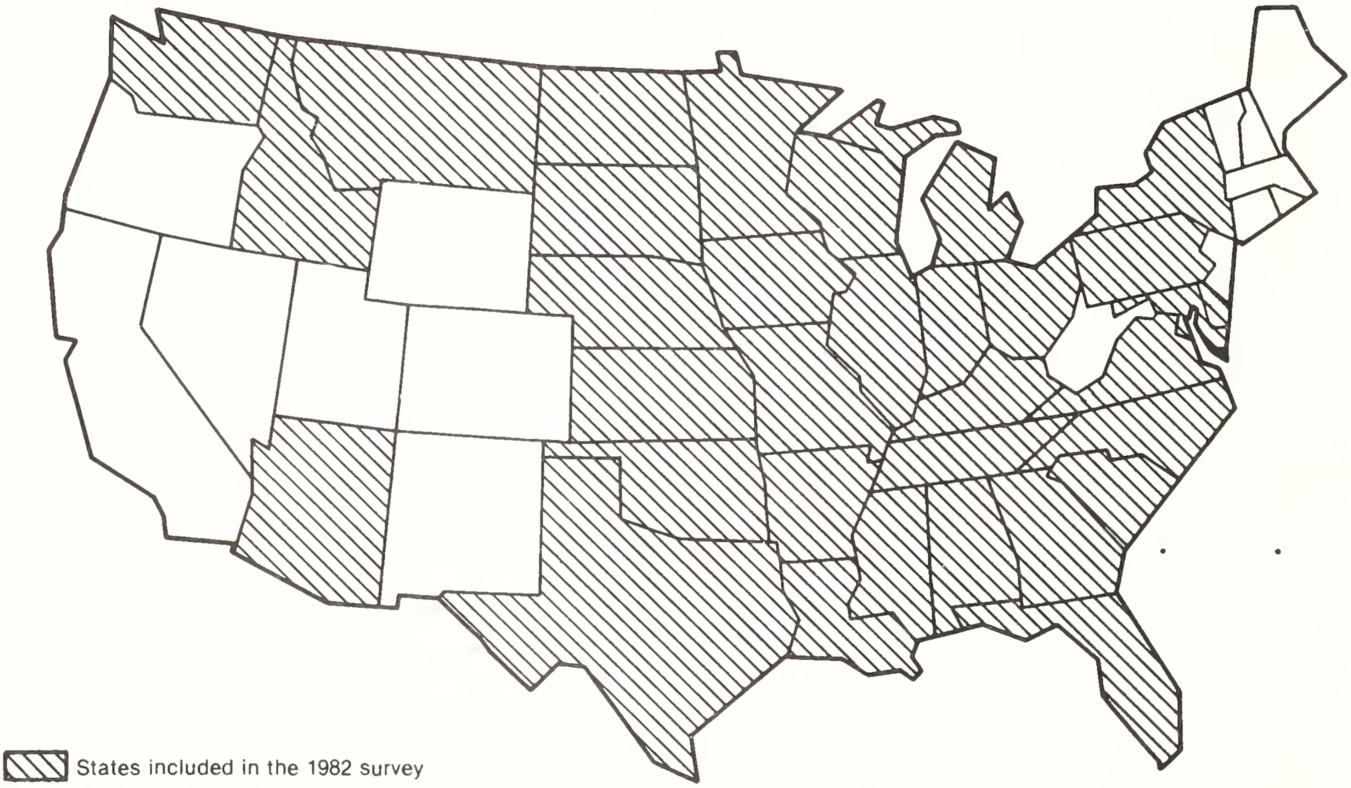
Table 10.—Extent of coverage for the 1982 Crop and Livestock Pesticide Usage Survey

Crop	U.S. planted acres	Surveyed States: Acres	Surveyed States: U.S. share	Farmers responding
	Million	*Million*	*Percent*	*Number*
Row crops:				
Corn	81.9	79.4	97	2,330
Soybeans	72.2	72.0	99	2,382
Cotton	11.4	10.0	88	868
Grain sorghum	16.1	15.2	94	712
Peanuts	1.3	1.3	99	386
Tobacco	0.9	0.9	99	640
Total	183.8	178.8	97	
Small grain crops:				
Rice	3.3	2.7	82	740
Wheat	87.3	79.8	91	2,207
Barley and oats	23.8	21.4	90	1,439
Total	114.4	103.9	91	
Forage crops:				
Alfalfa	26.5	22.6	85	1,405
Other hay	34.1	29.8	87	1,990
Pasture and range	436.7	300.5	69	3,740
Total	497.3	352.9	71	
Total	795.5	635.6	80	

Sources: (1, 14).

Figure 1

States Included in the 1982 Crop and Livestock Pesticide Usage Survey



243 million pounds on corn, which accounted for 54 percent of the total herbicides used on the surveyed crops. Soybean farmers applied 125 million pounds, or 28 percent of the total.

Ninety-three percent or more of the acres planted to four of the six major U.S. row crops was treated with herbicides in 1982, with tobacco and grain sorghum treated acres totaling 71 and 59 percent, respectively. Almost all of the rice acreage was treated with herbicides, while only 42 to 45 percent of the wheat and other small grain acreages were treated. In the spring wheat areas of the Northern Plains, over 90 percent of the acreage was treated with herbicides, while winter wheat grown in the Southern and Central Plains required little herbicide treatment. Winter wheat competes well with summer annual weeds, while spring wheat is planted and emerges at the same time as most weeds.

Herbicide use is minimal on forage crops, pasture, and range. Only 6 million pounds (a.i.) were applied on 1 to 3 percent of the forage crop acreages in 1982.

Insecticides

Insecticide use on the major field and forage crops totaled 71 million pounds (a.i.) in 1982, down from 130 million pounds in 1976 (table 4). The use of insecticides on cotton accounted for 79 percent of the total decline, as some cotton farmers shifted to synthetic pyrethroids, which are applied at 0.1 to 0.2 pound (a.i.) per acre, compared with traditional cotton materials applied at 1 to 3 pounds per acre. In 1982, corn farmers applied 30 million pounds of insecticides and cotton farmers applied 17 million pounds. Corn and cotton uses accounted for 43 and 24 percent, respectively, of the total insecticides applied to the major field and forage crops in 1982, compared with 25 and 49 percent in 1976.

The share of total field and forage crop acres treated with insecticides has remained fairly stable, ranging from 6 to 9 percent between 1971 and 1982. In any year, however, insecticide use can fluctuate dramatically depending on the extent and intensity of insect infestations. Corn acreage treated with insecticides has remained constant at 35 to 38 percent, with most applications made to control corn rootworm larvae. The proportion of cotton acreage treated with insecticides decreased from about 60 percent in 1971 and 1976 to 36 percent in 1982. In another USDA pesticide use survey conducted in 1979, cotton farmers indicated they treated 48 percent of their acreage with insecticides (2). Cotton insecticide use decreased in part because of integrated pest management programs, which involve scouting for insect pests. These programs encourage farmers to time their insecticide applications more efficiently and to use nonchemical pest control techniques.

Pesticide Use Trends

The major herbicide materials used by U.S. farmers have changed over time; nine materials accounted for 68 to 80 percent of the total quantity applied from 1971 to 1982

(table 5). Materials applied to corn and soybeans comprised about 80 percent of the total herbicides applied in 1982. Atrazine, 2,4-D, and propachlor were the most important herbicides in 1971, while alachlor, atrazine, and butylate+ were the dominant materials in 1982.

Changes in the major insecticide materials between 1971 and 1982 were more noticeable than herbicide use changes. New insecticides were introduced while older ones were either taken off the market or banned from agricultural use. Methyl parathion and toxaphene use decreased substantially between 1976 and 1982 as cotton farmers switched to synthetic pyrethroids. The major corn and cotton insecticides in 1982 accounted for nearly three-fourths of all materials applied.

For the other pesticide classes (fumigants, fungicides, miticides, etc.), quantities were relatively small and use patterns fairly stable over the 1971-82 period, with the exception of desiccant and defoliant use, which decreased significantly since 1971. Specific use data for these pesticide classes are presented where appropriate for the individual survey crops.

Table 11.—Corn pesticide use, 1976 and 1982

Pesticide	Acres treated		Pounds (a.i.)	
	1976	1982	1976	1982
	Million			
Herbicides:				
Alachlor	34.3	26.4	58.2	52.3
Atrazine	56.9	47.9	83.8	69.7
Butylate+	8.2	14.9	24.3	54.9
Cyanazine	6.6	13.1	10.4	20.7
Dicamba	4.4	8.9	1.4	2.1
EPTC+	2.6	1.8	8.2	8.3
Linuron	1.2	0.4	1.6	0.3
Metolachlor	—	11.6	—	21.7
Propachlor	4.2	1.4	7.7	3.5
Simazine	1.8	3.3	2.4	3.3
2,4-D	12.5	11.3	8.0	5.1
Other	1.2	2.3	1.1	1.5
Total	133.9	143.3	207.1	243.4
Insecticides:				
Carbaryl	2.1	0.1	2.1	0.2
Carbofuran	9.3	5.5	9.9	5.2
Chlorpyrifos	—	3.4	—	3.9
Diazinon	1.1	0.2	0.8	0.2
EPN	0.5	—	0.1	—
Ethoprop	0.2	0.7	0.2	0.7
Fensulfothion	0.7	—	0.5	—
Fonofos	5.5	5.6	5.0	5.1
Isofenphos	—	0.9	—	1.3
Methyl parathion	0.7	0.2	0.2	*
Organochlorines[1]	3.2	—	3.9	—
Parathion	1.6	0.2	0.6	0.1
Phorate	6.1	3.7	5.8	3.8
Terbufos	2.2	7.7	2.5	8.7
Toxaphene	0.2	0.3	0.1	0.6
Other[2]	0.5	0.8	0.3	0.3
Total	33.9	29.3	32.0	30.1
Fungicides	*	0.1	*	0.1
Total	167.8	172.7	239.1	273.6

— = None reported.

* = Less than either 50,000 acres or pounds (a.i.).

[1]Includes aldrin, chlordane, and heptachlor. [2]Includes nematicides.

Sources: (10, 11).

Corn—Farmers applied 243 million pounds (a.i.) of herbicides in 1982, up 18 percent from 1976 (table 11). Propachlor and 2,4-D use declined significantly, while butylate+ and cyanazine use increased substantially. Metolachlor, registered in 1974, became the fourth leading corn herbicide in 1982 with 21.7 million pounds. Terbufos, carbofuran, and fonofos were the most common corn insecticides in 1982, compared with carbofuran, phorate, and fonofos in 1976.

Soybeans—Herbicide use on soybeans totaled 125 million pounds (a.i.) in 1982, a gain of 54 percent since 1976 (table 12). The dramatic increase resulted primarily from a 44-percent increase in soybean planted acres and a higher proportion of the planted acres treated with herbicides (88 percent in 1976 compared with 93 percent in 1982) (table 2).

Use of the major soybean herbicides either remained constant or increased between 1976 and 1980. Trifluralin, metribuzin, and bentazon use rose significantly. Metolachlor was the third-leading herbicide in 1982, although none was reported in 1976. Insecticide use on soybeans is small compared with use on corn or cotton. There have been no substantial product changes in recent years except for the introduction of synthetic pyrethroids.

Other Row Crops—Total pesticide use on cotton, grain sorghum, peanuts, and tobacco is small compared with quantities applied to corn and soybeans. However, pesticides are important in the production of these crops. Cotton farmers are using new herbicides—cyanazine, fluchloralin, and norflurazon—but trifluralin, MSMA, and

Table 12.—Soybean pesticide use, 1976 and 1982

Pesticide	Acres treated		Pounds (a.i.)	
	1976	1982	1976	1982
	Million			
Herbicides:				
Alachlor	18.7	18.3	29.6	30.9
Bentazon	5.3	11.6	3.8	8.1
Chloramben	3.7	4.4	4.4	6.0
Dinoseb	4.2	5.6	3.7	4.3
Linuron	10.4	8.3	6.2	5.8
Metolachlor	—	7.1	—	12.9
Metribuzin	8.5	23.6	5.2	10.2
Naptalam	3.1	3.3	3.9	4.4
Trifluralin	24.2	33.6	21.1	30.7
Other	3.9	19.9	3.2	11.9
Total	82.0	135.7	81.1	125.2
Insecticides:				
Carbaryl	2.9	2.0	3.7	1.5
Disulfoton	0.2	0.1	0.2	0.1
Methomyl	0.9	1.7	0.5	0.7
Methyl parathion	0.7	3.4	0.7	2.6
Parathion	0.4	—	0.3	—
Synthetic pyrethroids	—	3.4	—	0.6
Toxaphene	0.5	1.9	2.2	3.7
Other	0.3	1.3	0.3	1.7
Total	5.9	13.8	7.9	10.9
Fumigants	0.5	—	2.0	—
Fungicides	1.2	0.2	0.2	0.1
Total	89.6	149.7	91.2	136.2

— = None reported

Sources: (10, 11)

fluometuron are still the most commonly used cotton herbicide materials (table 13). The shift by cotton farmers to synthetic pyrethroids partially accounts for the large drop in the use of EPN, methyl parathion, and toxaphene.

Cotton desiccant and defoliant use declined from 8.4 million pounds (a.i.) in 1976 to 7 million in 1982. Sodium chlorate, arsenic acid, and DEF were the most commonly used materials in 1982.

Atrazine and propachlor were the two most commonly used grain sorghum herbicides in 1982 (table 14). Propazine and 2,4-D use declined between 1976 and 1982. Grain sorghum farmers primarily applied one of several insecticides—carbofuran, malathion, or parathion.

Peanut farmers use herbicides, insecticides, and fungicides extensively (table 15). In 1982, several insecticides dominated the peanut market, alachlor and benefin were the major herbicides, and chlorothalonil accounted for most of the fungicide applications.

Tobacco farmers use five different classes of pesticides. In 1982, fumigants and plant growth regulators accounted for 68 percent of the tobacco pesticide use (table 16). D-D mixture was the most commonly used fumigant, while fatty alcohols and maleic hydrazide accounted for all of the plant growth regulators reported. Ethoprop was the most commonly used insecticide/nematicide in 1976 and 1982. When used as a nematicide, it is applied at rates of 4 to 6 pounds (a.i.) per acre. Diphenamid, isopropalin, and pebulate were the major tobacco herbicides. Metalaxyl, a recently introduced fungicide, accounted for 80 percent of the total fungicide use.

Small Grain Crops—Propanil was the most commonly used rice herbicide in both 1976 and 1982 (table 17). Carbofuran and methyl parathion were the insecticides used most widely on rice in 1982.

The use of 2,4-D for broadleaf weed control on wheat declined 35 percent between 1976 and 1982 (table 18). Also, triallate use increased fourfold for wild oat control. The use of trifluralin, difenzoquat, and diclofop methyl (a new material) on wheat increased, while insecticide use dropped substantially between 1976 and 1982.

Major herbicides used on barley and oats were 2,4-D, MCPA, and triallate (table 19). Insecticide use was minimal on these small grain crops in 1982, although carbaryl was the primary material for both crops.

Livestock—Insect control costs ranged from about $79 per farm for hog operations to $111 per farm for beef cat-

Table 13.—Cotton pesticide use, 1976 and 1982

Pesticide	Acres treated		Pounds (a.i.)	
	1976	1982	1976	1982
	Million			
Herbicides:				
Cyanazine	—	0.7	—	0.6
Diuron	1.1	0.6	0.4	0.3
DSMA	1.2	0.6	1.5	0.9
Fluchloralin	—	0.3	—	0.3
Fluometuron	5.2	3.4	5.3	2.9
Linuron	0.9	0.4	0.4	0.2
MSMA	2.5	2.4	1.8	3.6
Norflurazon	—	0.6	—	0.5
Pendimethalin	*	1.0	*	0.6
Prometryn	0.9	1.0	0.7	1.0
Trifluralin	9.1	5.6	7.0	4.3
Other	2.3	2.1	1.2	2.1
Total	23.2	18.7	18.3	17.3
Insecticides:				
Azinphosmethyl	0.4	1.0	0.2	0.6
Chlordimeform	2.9	2.3	4.4	0.7
Dicrotophos	0.7	0.6	0.3	0.2
Disulfoton	1.4	*	1.8	*
EPN	1.5	1.1	6.1	1.4
Methomyl	0.8	0.9	0.6	0.5
Methyl parathion	6.2	3.8	20.0	7.2
Monocrotophos	1.5	0.4	1.5	0.3
Sulprofos	—	0.6	—	0.5
Synthetic pyrethroids	—	4.7	—	2.0
Toxaphene	3.1	0.6	26.3	1.2
Other	2.2	0.5	2.9	2.3
Total	20.7	16.5	64.1	16.9
Desiccants and defoliants:				
Arsenic acid	0.4	0.5	1.7	2.2
DEF	2.3	1.5	3.4	1.7
Sodium chlorate	1.4	0.9	3.3	2.7
Other	*	0.7	*	0.4
Total	4.1	3.6	8.4	7.0
Fungicides	1.2	0.5	3.5	0.2
Miticides	0.5	0.1	0.4	0.2
Total	49.7	39.4	94.7	41.6

— = None reported.

* = Less than either 50,000 acres or pounds (a.i.)

Sources: (10, 11).

Table 14.—Grain sorghum pesticide use, 1976 and 1982

Pesticide	Acres treated		Pounds (a.i.)	
	1976	1982	1976	1982
	Million			
Herbicides:				
Atrazine	4.9	5.9	6.5	6.3
Dicamba	0.6	0.5	0.4	0.1
Metolachlor	—	1.4	—	2.0
Propachlor	1.1	2.0	3.1	4.3
Propazine	2.4	1.6	3.9	1.3
Terbutryn	—	0.4	—	0.6
2,4-D	2.6	1.2	1.4	0.5
Other	0.4	0.6	0.4	0.2
Total	12.0	13.6	15.7	15.3
Insecticides:				
Carbofuran	0.4	1.0	0.2	0.9
Chlorpyrifos	—	0.4	—	0.2
Dimethoate	0.8	0.3	0.3	0.1
Disulfoton	1.5	*	1.1	*
Malathion	0.2	0.6	0.4	0.5
Methyl parathion	0.2	0.1	0.1	0.1
Parathion	2.0	0.8	1.2	0.4
Phorate	0.3	*	0.1	*
Toxaphene	0.3	*	1.0	*
Other	0.1	0.7	0.2	0.3
Total	5.8	3.9	4.6	2.5
Total	17.8	17.5	20.3	17.8

— = None reported.

* = Less than either 50,000 acres or pounds (a.i.).

Sources: (10, 11).

tle operations in 1982 (table 20). In the USDA pesticide use survey, livestock farmers reported insecticide use in terms of dollars spent, rather than in pounds applied, as reported by field and forage crop farmers. Most livestock insecticide costs were incurred for direct applications to animals. Dust bags, ear tags, foggers, oilers, and sprayers were the primary fly control techniques used on beef and dairy cattle (table 21). Hog farmers depended more on indirect fly control techniques, such as sprayers and fly strips. Lice were the predominant non-fly pest problem for all livestock producers. Many cattle farmers also applied insecticides to control cattle grubs and ticks, while a large proportion of the hog farmers applied pesticides to control mange.

Pest Scouting

Cotton farmers use professional scouting more extensively than any other group of farmers. In 1982, 41 percent of the planted cotton acreage was professionally scouted (table 22). Approximately one-fifth of both the planted grain sorghum and peanut acreage was also professionally scouted. Between 60 and 80 percent of the row crop acreages and from 39 to 89 percent of the small grain crop acreages were scouted by farmers, family members, or farm employees.

Table 15.—Peanut pesticide use, 1976 and 1982

Pesticide	Acres treated		Pounds (a.i.)	
	1976	1982	1976	1982
	Million			
Herbicides:				
Alachlor	0.4	0.5	0.7	1.2
Benefin	0.8	0.7	0.8	1.0
Dinoseb	0.3	0.4	0.3	0.4
Metolachlor	—	0.2	—	0.4
Naptalam	0.2	0.3	0.4	0.6
Trifluralin	0.3	0.1	0.2	0.1
2,4-DB	0.2	0.3	*	0.2
Vernolate	0.5	0.3	0.9	0.7
Other	0.1	0.3	0.1	0.3
Total	2.8	3.1	3.4	4.9
Insecticides:				
Aldicarb	*	0.2	*	0.2
Carbaryl	0.2	0.2	0.3	0.2
Carbofuran	0.3	0.1	0.5	0.1
Methomyl	0.2	0.2	0.6	0.1
Monocrotophos	0.2	0.1	0.2	*
Toxaphene	0.1	*	0.4	0.1
Other	0.4	0.1	0.4	0.3
Total	1.4	0.9	2,4	1.0
Fumigants	0.1	0.1	0.4	1.6
Fungicides:				
Benomyl	0.5	0.1	1.6	0.1
Chlorothalonil	0.9	1.1	4.4	4.1
PCNB	0.1	*	0.8	0.1
Other	0.3	0.2	0.8	0.5
Total	1.8	1.4	7.6	4.8
Total	6.1	5.5	13.8	12.3

— = None reported.

* = Less than either 50,000 acres or pounds (a.i.).

Sources: (10, 11).

Table 16.—Tobacco pesticide use, 1976 and 1982[1]

Pesticide	Acres treated		Pounds (a.i.)	
	1976	1982	1976	1982
	Million			
Herbicides:				
Diphenamid	0.2	0.1	0.5	0.3
Isopropalin	0.2	0.2	0.3	0.3
Pebulate	0.1	0.1	0.3	0.3
Pendimethalin	—	0.1	—	0.1
Other	*	0.1	0.1	0.5
Total	0.5	0.6	1.2	1.5
Insecticides:				
Acephate	*	0.5	*	0.7
Carbaryl	0.2	0.1	0.5	0.1
Disulfoton	0.2	*	0.2	0.1
Ethoprop	0.2	0.2	0.8	1.3
Fensulfothion	*	0.1	0.2	0.3
Methomyl	0.2	0.1	0.7	0.1
Monocrotophos	0.1	0.1	0.2	0.1
Other	0.6	0.3	0.6	0.8
Total	1.5	1.4	3.2	3.5
Fumigants:				
Chloropicrin	0.4	0.1	1.3	1.0
D-D mixture	*	0.1	1.2	4.5
Ethylene dibromide	0.1	*	1.7	0.4
Methyl bromide	0.5	—	6.6	—
Telone	*	—	1.5	—
Total	1.0	0.2	12.3	5.9
Fungicides:				
Ferbam	0.1	—	0.1	—
Maneb	*	*	*	*
Metalaxyl	—	0.4	—	0.4
Other	*	0.1	*	0.1
Total	0.1	0.5	0.1	0.5
Plant growth regulators:				
Fatty alcohols	0.4	0.3	3.1	4.0
Maleic hydrazide	0.9	0.8	3.2	2.0
Total	1.3	1.1	6.3	6.0
Total	4.4	3.8	23.1	17.4

— = None reported.

* = Less than either 50,000 acres or pounds (a.i.).

[1]Plantbeds not included.

Sources: (10, 11).

Table 17.—Rice pesticide use, 1976 and 1982

Pesticide	Acres treated		Pounds (a.i.)	
	1976	1982	1976	1982
	Million			
Herbicides:				
Molinate	0.7	1.0	1.2	2.6
Propanil	1.9	2.3	6.9	8.4
Other	1.0	2.1	0.4	2.9
Total	3.6	5.4	8.5	13.9
Insecticides:				
Carbofuran	0.4	0.2	0.4	0.1
Malathion	0.2	*	0.1	*
Methyl parathion	*	0.3	*	0.2
Other	—	0.2	—	0.3
Total	0.6	0.7	0.5	0.6
Total	4.2	6.1	9.0	14.5

* = Less than either 50,000 acres or pounds (a.i.).

— = None reported.

Sources: (10, 11).

Regulatory Actions

The Environmental Protection Agency (EPA) announced several regulatory actions in the past several months. Two actions may have major economic impacts on some U.S. farmers.

Ethylene dibromide (EDB)—The EPA action to limit EDB to only minor uses could adversely affect agriculture and related sectors of the U.S. economy. The regulatory action was announced on September 30, 1983. EDB has been registered as a pesticide since 1948 and has more than 30 current agricultural uses. Over 20 million pounds (a.i.) of EDB are used annually. EPA cited the following reasons for its action: Residues in food products, contamination of ground water, applicator exposure, and worker exposure when handling fumigated commodities.

EDB has been used to fumigate soils for a wide variety of crops, to treat stored grain and grain milling machinery, for quarantine treatment of fruits and vegetables to prevent the spread of fruit flies, and for a number of other minor purposes. The loss of EDB for soil fumigation will increase nematode control costs for affected producers and could result in crop losses for some fruit and vegetable producers. Furthermore, the loss of EDB may result in the spread of the burrowing nematode, a Florida citrus pest.

Without EDB, grain mill operators may not be able to effectively control insects in their machinery. EDB is the preferred material for controlling insects in stored grain under some conditions. Insects in stored grain can be controlled with other pesticides, although control costs are higher for some users.

There are no readily available alternatives for quarantine uses of EDB. An 11-month phaseout period was established for the development of alternative control methods. Some methods are in an experimental stage, but their technical and economic feasibility have not been determined. If suitable alternatives are not developed, U.S. citrus growers may lose export markets in Japan, and some fresh fruit and vegetable interstate shipments (primarily to Arizona and California) will be prohibited to prevent the spread of fruit fly infestations. Florida and Texas citrus regions could lose markets for about 10 to 15 percent of their fresh grapefruit production.

Table 18.—Wheat pesticide use, 1976 and 1982

Pesticide	Acres treated		Pounds (a.i.)	
	1976	1982	1976	1982
	Million			
Herbicides:				
Barban	1.0	0.3	0.2	0.1
Bromoxynil	2.4	2.5	0.9	0.7
Dicamba	3.5	5.4	1.5	0.7
Diclofop methyl	—	0.8	—	0.7
Difenzoquat	*	0.5	*	0.4
MCPA	3.4	5.1	1.2	1.8
Picloram	1.0	0.5	0.4	*
Terbutryn	0.6	—	0.8	—
Triallate	0.7	2.4	0.6	2.4
Trifluralin	*	1.8	*	0.8
2,4-D	30.2	23.3	15.5	10.1
Other	0.8	0.6	0.8	0.3
Total	43.6	43.2	21.9	18.0
Insecticides:				
Diazinon	0.2	—	0.1	—
Dimethoate	0.1	0.5	0.1	0.2
Disulfoton	3.7	*	1.8	*
Endrin	0.9	—	0.2	—
Malathion	0.2	0.1	0.1	0.1
Methyl parathion	3.4	0.6	1.2	0.4
Parathion	6.4	1.7	3.1	1.5
Toxaphene	0.4	0.1	0.6	0.1
Other	0.4	0.1	*	0.1
Total	15.7	3.1	7.2	2.4
Fungicides:				
Copper sulfate	0.6	—	0.9	—
Mancozeb	—	0.2	—	0.3
Maneb	—	0.5	—	0.7
Total	0.6	0.7	0.9	1.0
Total	59.9	47.0	30.0	21.4

— = None reported.

* = Less than either 50,000 acres or pounds (a.i.).

Sources: (10, 11).

Table 19.—Other small grain pesticide use, 1976 and 1982[1]

Pesticide	Acres treated		Pounds (a.i.)	
	1976	1982	1976	1982
	Million			
Herbicides:				
Barban	0.2	0.1	*	0.1
Bromoxynil	0.2	0.7	0.1	0.2
Dicamba	0.6	0.5	0.1	0.3
MCPA	3.2	3.8	1.1	1.4
Triallate	0.2	1.0	0.2	1.3
2,4-D	7.5	5.3	3.8	2.5
Other	0.2	0.8	0.2	0.1
Total	12.1	12.2	5.5	5.9
Insecticides:				
Carbaryl	0.7	0.1	1.2	0.1
Methyl parathion	0.2	*	0.2	*
Parathion	0.1	0.1	0.1	*
Phorate	0.1	*	0.1	*
Toxaphene	0.2	*	0.2	*
Other	0.1	*	*	0.1
Total	1.4	0.2	1.8	0.2
Total	13.5	12.4	7.3	6.1

* = Less than either 50,000 acres or pounds (a.i.).

[1]Includes barley, oats, and rye in 1976 and barley and oats in 1982.

Sources: (10, 11).

Table 20.—Average livestock insect control costs, 1982[1]

Livestock type	Direct applications to animals	Applications to buildings and vicinity	All applications
	Dollars per operation		
Beef cattle	109.78	24.22	111.37
Dairy cattle	90.76	57.04	105.87
Hogs	65.46	49.25	79.49

[1]Average cost figures for direct and indirect applications do not add to the figures for all applications because livestock farmers do not necessarily make both types of applications.

Source: (1).

Following are the specific EDB regulatory actions established by EPA:

-Current EDB Use-	-Approximate Annual Use-	-Regulatory Action-
Soil fumigation of soybeans, cotton, peanuts, pineapples, and 30 other fruit and vegetable crops	Over 20 million pounds (a.i.)	Immediate suspension of use and cancellation
Stored grain fumigation	Less than 500,000 pounds (a.i.)	Cancellation in 30 days
Spot fumigation of grain milling machinery	Less than 500,000 pounds (a.i.)	Cancellation in 30 days
Fumigation of felled logs	Less than 100,000 pounds (a.i.)	Cancellation in 30 days
Quarantine fumigation of citrus, other fruits, and vegetables	Less than 100,000 pounds (a.i.)	Cancellation effective September 1, 1984
Minor uses—beehives, storage vaults, and termite control	Less than 100,000 pounds (a.i.)	Retain use with additional precautions and restrict use to certified applicators

2,4,5-T and silvex —The Dow Chemical Company notified EPA on October 14, 1983, that it was terminating its participation in the 2,4,5-T and silvex cancellation hearings. In a separate action, Dow also requested EPA to cancel its domestic 2,4,5-T and silvex registrations. Because of Dow's action, EPA plans to publish in the Federal Register a new notice of intent to cancel, under FIFRA section 6(b)1, the registrations of all 2,4,5-T and silvex products not previously suspended. The suspended uses include those for forestry, rights-of-way, and pasture for 2,4,5-T and silvex, and home and garden, commercial/ornamental turf, and aquatic weed and ditchbank applications for silvex.

End uses covered by the current EPA notice include applications on rice, rangeland, sugarcane, orchards, and all miscellaneous noncrop areas. Registrants or other interested parties have 30 days to request hearings. Otherwise, the registrations will be automatically cancelled. EPA will permit, however, the continued distribution and sale of existing stocks for labeled uses for no more than 1 year from the effective date of cancellation.

Table 21.—Proportion of livestock farmers using insect control methods, 1982[1]

Item	Beef cattle farmers	Dairy cattle farmers	Hog farmers
		Percent	
	Fly control methods		
Dust bags	31	31	3
Ear tags	23	13	—
Foggers	3	20	5
Mist blowers	4	10	4
Oilers or back rubs	25	10	6
Other sprayers	36	39	24
Other	0	0	[2]61
None	10	9	33
	Non-fly livestock pests		
Cattle grubs	45	24	—
Lice	63	57	66
Mange	10	8	40
Ticks	29	13	—
Other	5	5	3

— = Not applicable.

[1]Columns for each group can sum to more than 100 percent because of multiple responses. [2]Primarily fly strips.

Source: (1).

Table 22.—Planted field crop acreages scouted for insect pests, 1982

Crop	Professional scouting	Self scouting
	Percent	
Row crops:		
Corn	7	60
Soybeans	7	66
Cotton	41	61
Grain sorghum	18	63
Peanuts	19	80
Tobacco	4	76
Small grain crops:		
Rice	12	89
Wheat	5	51
Barley and oats	3	39
Forage crops:		
Alfalfa	4	20
Other hay	*	7
Pasture and range	*	43

* = Less than 1 percent.

Source: (1).

Corn and Soybean Pest Management Practices For Alternative Tillage Strategies

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Abstract: Per-acre weed control costs do not vary significantly for most U.S. corn and soybean farmers using different tillage strategies. However, Midwest no-till soybean farmers incur significantly higher weed control costs than other Midwest soybean farmers because they apply more herbicides. In general, conservation-till corn and soybean farmers substitute broad spectrum herbicide applications for mechanical cultivation to control weeds. Per-acre insecticide use and costs are not significantly different among tillage strategies for soybean farmers. No-till corn farmers, however, apply significantly more insecticides than other corn farmers. Per-acre returns are not significantly different among tillage strategies for corn and soybean farmers, except in the Midwest where conventional-till soybean farmers harvest a significantly higher yield than no-till soybean farmers.

Keywords: Herbicide and insecticide use and costs, mechanical cultivation, returns, tillage practices, corn, soybeans, major producing regions.

Corn and soybean production data for 1980 were analyzed to determine per-acre input use, input costs, and returns to alternative tillage practices. Corn and soybean input use varies among tillage strategies because of differences in field operations and the subsequent impact on soil characteristics. The affected inputs include labor, fuel and repairs, machinery, fertilizers, pesticides, and seed. This report focuses on the differences in weed and insect control practices among tillage strategies. See "Returns to Corn and Soybean Tillage Practices", Agricultural Economic Report No. 508, for a more detailed discussion.

Tillage Practices

Many U.S. corn and soybean farmers have modified their tillage practices in recent years, in an attempt to cut production costs and soil loss and to increase net returns. Historically, U.S. corn and soybean farmers have used tillage practices that involve extensive field preparation prior to planting, including the use of a moldboard or disk plow to turn the soil, and other field operations to prepare a seedbed. These activities cause all or most plant residue to be incorporated into the soil, leaving fields totally exposed to wind and water erosion.

Conservation tillage practices, which include no-till and reduced-till strategies, leave more plant residue on the field surface and involve less soil disturbance than conventional tillage strategies. Conservation tillage reduces soil loss, increases soil moisture levels, lowers soil temperatures, and causes farmers to adjust their input use.

No-till is defined as a strategy where plant residue is left virtually undisturbed on the field surface. The soil is broken only where the seeds are planted. Reduced-till strategies include those in which field preparation involves some soil breakage, usually with a chisel plow. Also, plant residue is only partially disturbed.

Conservation tillage practices are being adopted by more U.S. corn and soybean farmers each year (table 23). The proportion of corn acreage planted to no-till strategies increased from 1 to 4 percent between 1980 and 1982. Likewise, the proportion of reduced-till soybean acreage increased 50 percent in the Midwest, 100 percent in the Midsouth, and 167 percent in the Southeast.

Weed Control

Corn and soybean herbicide use changes as the extent to which fields are tilled lessens. Herbicide applications are substituted for tillage operations and mechanical cultivation. Higher herbicide application rates are necessary because increased plant residue ties up a portion of the applied materials and increased soil moisture conditions in conservation-till fields provide a better growing habitat for weeds. Conservation-till farmers, particularly no-till farmers, make additional herbicide applications with postemergent materials such as paraquat or glyphosate.

Herbicides were applied to virtually all planted corn acreage (98 percent) in 1980 to control prevalent weeds such as cocklebur, foxtail, and velvetleaf. Pounds (active ingredients, a.i.) of herbicides applied per acre were not significantly different among the three tillage strategies (table 24). There were, however, substantial differences in average herbicide costs, with no-till corn farmers spending significantly more than either reduced- or conventional-till farmers. No-till corn farmers applied a different mix of materials, specifically more expensive broad spectrum herbicides, to effectively control weed infestations.

Table 23.—Planted corn and soybean acres by tillage practices, 1980 and 1982

Crop, region	No-till		Reduced-till		Conventional-till	
	1980	1982	1980	1982	1980	1982
	Thousand acres (percent)					
Corn:						
10 major producing States[1]	886 (1)	2,701 (4)	25,464 (40)	26,937 (42)	37,450 (59)	34,062 (54)
Soybeans:						
Midwest[2]	793 (2)	1,193 (3)	10,313 (26)	16,139 (39)	28,558 (72)	24,201 (58)
Midsouth[3]	758 (4)	1,006 (6)	1,704 (9)	3,159 (18)	16,474 (87)	13,452 (76)
Southeast[4]	248 (4)	281 (4)	930 (15)	2,729 (40)	5,022 (81)	3,740 (56)

[1]Includes Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin. [2]Includes Illinois, Indiana, Iowa, Kansas, Kentucky excluding the extreme western counties, Minnesota, Missouri excluding the bootheel, Nebraska, and Ohio. [3]Includes Alabama, Arkansas, extreme western Kentucky, Louisiana, Mississippi, the bootheel of Missouri, and Tennessee. [4]Includes Georgia, North Carolina, and South Carolina

Table 24.—Per-acre corn and soybean weed control input use and costs for different tillage practices, 1980[1]

Region, tillage practice	Herbicide		Mechanical cultivation		Weed control cost
	Use	Cost	Use	Cost	
	Pounds (a.i.)	*Dollars*	*Number*	*Dollars*	*Dollars*
			Corn		
10 major producing States:					
No-till	3.50 A	17.24 A	0.35 A	1.51 A	18.75 A
Reduced-till	3.38 A	12.70 B	1.13 B	4.82 B	17.52 A
Conventional-till	3.00 A	11.39 B	1.13 B	4.82 B	16.21 A
			Soybeans		
Midwest:					
No-till	3.23 A	30.60 A	0.47 A	2.00 A	32.60 A
Reduced-till	1.86 B	17.65 B	1.19 B	5.09 B	22.74 B
Conventional-till	2.03 B	17.92 B	1.33 B	5.70 B	23.62 B
Midsouth:					
No-till	2.00 A	23.68 A	0.19 A	0.85 A	24.53 A
Reduced-till	1.74 A	18.33 A,B	1.42 B	6.33 B	24.66 A
Conventional-till	1.45 A	15.62 B	1.79 B	7.99 B	23.61 A
Southeast:					
No-till	1.68 A	18.87 A	0.00 A	0.00 A	18.87 A
Reduced-till	1.46 A	12.01 A	1.12 B	4.48 B	16.49 A
Conventional-till	1.38 A	10.87 A	1.73 B	6.96 B	17.83 A

[1]The Tukey-Kramer method was used to test for differences in means among tillage practices. Regional means in each column followed by different letters are significantly different from each other at the 5-percent level.

The proportions of Midwest, Midsouth, and Southeast planted soybean acres treated with herbicides in 1980 were 97, 91, and 76 percent, respectively. Cocklebur and morningglory were primary soybean weed pests in all regions. Foxtail and velvetleaf were major target weed pests in the Midwest, while crabgrass and johnsongrass were common weed pests in the Midsouth and Southeast.

Average per-acre herbicide use and cost for Midwest no-till soybean farmers were significantly higher than for other Midwest soybean farmers in 1980. The average amount of herbicides applied to Midsouth soybean fields planted under various tillage strategies was not significantly different. But, the average no-till herbicide material cost was significantly higher than the average conventional-till cost.

It appears that Midwest no-till soybean farmers applied greater amounts of herbicides and Midsouth no-till soybean farmers applied mixes of more expensive, broad spectrum materials than their respective regional counterparts using other tillage strategies. Soybean herbicide use and costs did not vary among tillage strategies in the Southeast.

Average herbicide use was higher for reduced-till and conventional-till soybean farmers in the Midwest than in the southern regions as well. But, reduced- and conventional-till soybean farmers in the southern regions generally cultivate their fields more times per season.

Although no-till farmers generally do not cultivate their fields, some cultivate when chemical weed control is ineffective. No-till corn farmers cultivated an average of 0.35 time during 1980, which was significantly lower than the average cultivations for the other corn farmers. They also applied broad spectrum herbicides as a substitute for fewer tillage operations and less mechanical cultivation.

No-till soybean farmers also mechanically cultivated their fields fewer times than either reduced- or conventional-till farmers in 1980 and, to a degree, used more herbicides. Midwest and Midsouth no-till soybean farmers cultivated their fields an average of less than one time per season, while Southeast no-till farmers reported they did not cultivate their fields. Midsouth reduced- and conventional-till soybean farmers cultivated more often than their respective counterparts in the Midwest and Southeast. Weed problems, especially perennial grasses, are generally more severe in the Midsouth than in the other growing regions. This may account for the higher number of cultivations in this region.

Except for Midwest soybean farmers, corn and soybean farmers using different tillage strategies in each region incurred similar weed control costs. As the degree to which fields are tilled lessens, per-acre herbicide applications increase. The decrease in mechanical cultivation costs is offset by an increase in herbicide costs. Midwest no-till soybean farmers, however, incurred a significantly higher per-acre weed control cost than the other Midwest soybean farmers.

Insect Control

Insecticide use also increases somewhat as tillage lessens. Increased plant residue, resulting from conservation tillage practices, can harbor increased insect infestations. Plant residue also ties up a portion of the materials applied. Insecticides were applied to 43 percent of the planted corn acreage in the study States during 1980, almost exclusively to prevent or control corn rootworm infestations.

Table 25.—Corn and soybean insecticide use and costs for different tillage practices, 1980[1]

Region, tillage practice	Per treated acre insecticide	
	Use	Cost
	Pounds (a.i.)	*Dollars*
	Corn	
10 major producing States:		
No-till	1.69 A	8.70 A
Reduced-till	1.09 B	7.44 A
Conventional-till	1.09 B	7.65 A
	Soybeans[2]	
Midwest:		
No-till	— A	0.00 A
Reduced-till	0.87 A	7.10 A
Conventional-till	0.80 A	3.45 A
Midsouth:		
No-till	0.49 A	3.44 A
Reduced-till	1.22 A	4.48 A
Conventional-till	0.99 A	5.96 A
Southeast:		
No-till	1.61 A	10.32 A
Reduced-till	0.91 A	4.90 A
Conventional-till	1.14 A	7.94 A

— = None reported.

[1]The Tukey-Kramer method was used to test for differences in means among tillage practices. Regional means in each column followed by different letters are significantly different from each other at the 5-percent level. [2]Although some absolute values vary substantially, they are not significantly different due to large sample size differences.

Corn insecticide use patterns differed from herbicide use patterns in that there were significant differences in the average quantities of insecticides applied, but not average costs (table 25). No-till corn farmers applied significantly higher rates of insecticides per acre than other farmers. However, average insecticide costs for the three groups of farmers were not significantly different because some no-till corn farmers used less expensive materials.

The proportion of planted soybean acres treated with insecticides in the Midsouth and Southeast totaled 17 and 57 percent, respectively, while only 2 percent were treated in the Midwest. Armyworm, bean leaf beetle, cabbage looper, and corn earworm were primary target insect pests in each region. Mexican bean beetle infestations were prevalent in the Midwest and velvetbean caterpillar was a major target pest in the Midsouth. The proportion of acres treated with insecticides was substantially higher in the Southeast because many soybean farmers applied soil insecticides to control nematodes.

Average per-acre insecticide use and costs were not significantly different among tillage strategies in any of the soybean regions during 1980. The average quantity and cost of Southeast soybean insecticide applications were generally higher than amounts in the other regions.

Costs and Returns

Differences in gross returns (yield times a weighted season average crop price), other input use and costs, and returns to alternative corn and soybean tillage strategies were also analyzed. Within growing regions, gross returns did not vary for corn and soybean farmers using different tillage strategies in 1980, except in the Midwest, where yields were significantly lower for no-till soybean farmers than for conventional-till soybean farmers (table 26).

Per-acre total affected costs for corn farmers did not vary significantly among tillage strategies. But, most conservation-till soybean farmers incurred significantly lower total affected costs than conventional-till soybean farmers. Reduced per-acre costs for some conservation-till farmers were offset by lower per-acre gross returns (yields). Per-acre returns were not significantly different for southern soybean farmers or corn farmers in the 10 major producing States using different tillages strategies. But, conventional-till soybean farmers in the Midwest accrued a significantly higher return than no-till soybean farmers, primarily because their yields were higher.

Table 26.—Corn and soybean costs and returns for different tillage practices, 1980[1]

Region, tillage practice	Gross return	Total affected costs[2]	Return
		Dollars per acre	
		Corn	
10 major producing States:			
No-till	319.81 A	154.18 A	165.63 A
Reduced-till	317.62 A	157.96 A	159.66 A
Conventional-till	307.17 A	159.45 A	147.72 A
		Soybeans[3]	
Midwest:			
No-till	209.51 A	97.03 A	112.48 A
Reduced-till	248.64 A,B	95.67 A	152.97 A,B
Conventional-till	262.49 B	106.95 B	155.54 B
Midsouth:			
No-till	116.15 A	87.96 A	28.19 A
Reduced-till	143.47 A	106.10 B	37.37 A
Conventional-till	151.00 A	119.06 C	31.94 A
Southeast:			
No-till	141.99 A	89.75 A	52.24 A
Reduced-till	131.05 A	103.89 A,B	27.16 A
Conventional-till	127.90 A	115.49 B	12.41 A

[1]The Tukey-Kramer method was used to test for differences in means among tillage practices. Regional means in each column followed by different letters are significantly different from each other at the 5-percent level. [2]Includes weed control, insect control, field preparation, fertilizer, and seed costs. [3]Although some absolute values vary substantially, they are not significantly different due to large sample size differences.

Conclusion

In the future, corn and soybean herbicide use will increase as more farmers adopt conservation tillage strategies. This trend should become more apparent as more effective postemergent herbicides are marketed. Total corn insecticide use will also increase slightly if no-till acreage increases because no-till corn farmers make larger early season insecticide applications than other farmers.

It appears that no one tillage strategy is clearly more advantageous for most U.S. corn and soybean farmers. The data indicate that farmers' tillage strategies should be based on their specific circumstances and an objective assessment of the relative input cost differences and returns to alternative tillage practices.

FERTILIZER

Outlook for 1983/84

U.S. fertilizer use will rebound in 1983/84 (year beginning July 1) as crop acreages are projected to increase. Fertilizer use in 1983/84 could be up about one-fifth from a year earlier. A sharp rise in corn and soybean planted acres will reverse a 2-year decline in fertilizer use. Higher crop price expectations should encourage farmers to maintain or increase application rates, but plant nutrient carryover on drought-affected acres could meet a part of the crop fertilizer requirements.

Total plant nutrient use is expected to advance to about 21.8 million tons in 1983/84. Nitrogen use is likely to increase to about 11.1 million tons, phosphate to 4.9 million tons, and potash to 5.8 million tons. After 2 years of holding steady or declining, fertilizer prices are expected to rise 8 to 10 percent in 1983/84. Overall prices could return to 1981/82 levels, with nitrogen prices advancing the most.

In recent years, low nitrogen fertilizer prices and increasing production costs have eliminated industry profits for all but the lower-cost producers. Domestic nitrogen producers are not expected to increase production without the incentive of higher prices. Foreign suppliers are anticipating higher prices in conjunction with a substantial increase in consumption during 1983/84.

U.S. nitrogen production could increase about 10 percent, but the production picture is not clear because of rising natural gas prices and uncertainty about longer-term fertilizer prices and production costs. Final 1983/84 nitrogen production will depend on when and how much idle production capacity is reopened. Shortfalls in supplies, due to delays in increasing U.S. nitrogen production, can readily be met with additional imports. Nitrogen imports could be up about 15 percent.

Although heightened export demand for diammonium phosphate will require more nitrogen, overall nitrogen exports could decline. Increased domestic use and higher prices will encourage U.S. producers to reduce exports below quantities exported in 1982/83. U.S. anhydrous ammonia producers are facing increasing production costs, making them less competitive in the world market.

Phosphate prices should move up modestly as the phosphate fertilizer industry attempts to improve profits in the face of increasing costs. However, ample production capacity will prevent any substantial price increases.

The United States is a major world supplier of phosphate. Domestic production is forecast to rise 8 percent in response to greater demand here and abroad. Exports should increase about 10 percent in 1983/84 as the world market continues to recover from the depressed 1981/82 levels.

Potash fertilizer suppliers can expect greater 1983/84 demand to exert some upward price pressure and improve industry profits, but excess North American production capacity and high inventories will limit price increases.

Most potash fertilizer used in the United States is imported from Canada, and Canadian imports could rebound 15 to 20 percent in 1983/84. U.S. potash production is expected to remain at close to year-earlier levels. Increased use, therefore, will be satisfied by imports.

Overall, world fertilizer supplies are expected to be adequate in 1983/84. The recovery in world fertilizer consumption will not exceed world supply capabilities.

Review of 1982/83 Inventories, Production, and Prices

Although U.S. fertilizer use dropped substantially in 1982/83, producers kept phosphate and nitrogen production in line with the lower demand and were able to achieve inventory management goals. Also, potash producers reduced inventories from excessive year-earlier levels, but inventories remained above normal.

Table 27.—U.S. production of nitrogen, phosphate, and potash (includes Canada), years ending June 30, 1982 and 1983

Plant nutrient	1982	1983	Change 1982-83
	Million short tons		*Percent*
Nitrogen	14.50	11.32	−22
Phosphate (P_2O_5)	8.77	9.45	+8
Potash (K_2O)			
Canada	6.66	5.93	−11
U.S.	2.16	1.81	−16

All figures subject to revision.

Source: (1, 6).

Nitrogen fertilizer production dropped sharply in 1982/83 in response to reduced domestic and export demand. Demand prospects early in the year indicated consumption would drop below year-earlier levels. High participation in the PIK program exacerbated the situation and further reduced demand (table 27).

June 1983 producer inventories of nitrogen fertilizer were down from the previous year. Declining anhydrous ammonia prices caused many high-cost plants to close. With reduced ammonia production, 1982/83 yearend ammonia inventories dropped about 6 percent from a year earlier.

Combined inventories of U.S. and Canadian potash producers increased slightly from June 1982 to June 1983. Higher Canadian producer stocks offset a more than 18-percent decline in U.S. producer inventories.

Prices

Reduced demand in 1982/83 caused fertilizer prices to decline. Farm prices in the spring of 1983 failed to recover as usual from autumn declines. Spring 1983 prices for concentrated superphosphate, diammonium phosphate, and muriate of potash were actually below fall 1982 prices (table 28). Compared with May 1982 prices, May 1983 anhydrous ammonia prices were down 7 percent. Muriate of potash prices, down 8 percent, declined the most.

Trade

The volume of plant nutrients exported in 1982/83 was almost the same as a year earlier, while the value declined about 14 percent. Import volume was down about 3 percent, with value down 8 percent. About 6 million metric tons of plant nutrients valued at $2.2 billion were exported by U.S. fertilizer producers. Imports of about 6.8 million metric tons were valued at $1.3 billion.

On a nutrient basis, imports of all nitrogen products in 1982/83 increased about 8 percent, primarily because of a 72-percent increase in urea imports (table 29). U.S. nitrogen exports declined 19 percent, equal the decline in 1981/82 (table 30). Diammonium phosphate, urea, and anhydrous ammonia accounted for 87 percent of the nitrogen exports, with shares of 40, 30, and 17 percent, respectively.

After a 1981/82 decline, phosphate exports increased about 4 percent to about 3.6 million metric tons. Exports

Table 28.—Average prices paid by U.S. farmers per ton for selected fertilizers.

Year	Anhydrous ammonia (82%)	Superphosphate (44-46%)	Diammonium-phosphate (18-46-0)	Potash (60%)	Mixed fertilizer (6-24-24)
			Dollars per ton		
1980: May	234	251	298	135	213
1981: May	247	249	283	155	226
1982: May	255	228	262	155	219
October	236	216	251	146	211
1983: May	237	214	249	143	206

Source: (3).

Table 29.—U.S. imports of plant nutrients, years ending June 30

Plant Nutrient	1982	1983	Change 1982-1983
	Million metric tons		*Percent*
Nitrogen	2.39	2.58	+8
Phosphate (P_2O_5)	.18	.12	−33
Potash (K_2O)	4.45	4.10	−8
Total	7.02	6.80	−3

Source: (5).

Table 30.—U.S. exports of plant nutrients, years ending June 30

Plant Nutrient	1982	1983	Change 1982-1983
	Million metric tons		*Percent*
Nitrogen	2.27	1.85	−19
Phosphate (P_2O_5)	3.40	3.55	+4
Potash (K_2O)	.56	.57	+2
Total	6.23	5.97	−4

Source: (4).

of normal and concentrated superphosphate, ammonium phosphates, and phosphate rock were up from a year earlier. At 1.9 million metric tons (P2O5), diammonium phosphates accounted for about 53 percent of U.S. exports of upgraded phosphate materials. Although phosphoric acid exports decreased, they still accounted for about 25 percent of all phosphate exports.

Potash imports declined 8 percent in 1982/83, following an 11-percent drop the year before. Although down from 4.3 million metric tons of nutrient, potassium chloride, at 4.0 million tons, was the largest potash import item. Canada provided about 89 percent of potassium chloride imports.

FARM MACHINERY

Earlier this year, farm machinery companies began major campaigns to reduce burgeoning inventories and to reverse declining sales. Inventory reduction efforts were somewhat successful as June 1983 stocks were lower than a year ago for four of the six major machinery items. Still, dealers had about a full year's supply of most machinery items in stock as of June 1983. Unit sales for the first 8 months of 1983 were up over the same period in 1982 for mower conditioners, remained unchanged for balers, and declined for wheel tractors, combines, and forage harvesters.

Factors Affecting 1983 Sales

Sales of major machinery items were affected by a number of important factors during the first 8 months of 1983. The PIK program generally resulted in improved 1983 farm income prospects last spring compared with 1982 and encouraged some farmers to purchase farm machinery. On the other hand, unusually late plantings and drought during the summer reduced corn and soybean yields drastically and dampened late-season demand for farm machinery.

Situation for Major Machinery Items

With 1983 acreage substantially lower than in 1982, farm machinery purchase and repair requirements decreased. Wheel tractors and combines have traditionally been the two most important components of North American full-line farm equipment manufacturers. The situation for these and other major machinery items follows.

Tractors—Total unit sales of tractors were lower for the first 8 months of 1983 than for the same period last year (table 31). Sales of two-wheel drive tractors over 40 horsepower were down about 13 percent compared to last year. Although sales of these tractors increased in May and June, probably in response to the PIK program, sales declined in July and August as the drought became widespread.

Domestic sales of two-wheel drive tractors were down about 10 percent, but export sales fell nearly 80 percent. If the current pace continues, total two-wheel drive tractor sales in 1983 will decline about 13 percent. Although the inventory of two-wheel drive tractors for mid-1983 improved relative to mid-year 1982, nearly a full year's supply remained unsold in June 1983 (table 32).

The 1983 picture for four-wheel drive tractors is more bleak than for two-wheel drive tractors. Unit sales of four-wheel drive tractors were lower each month of 1983 compared with a year earlier. Sales for the first 8 months of 1983 fell 43 percent from a year earlier, and are not expected to improve appreciably for the remainder of the year. Export sales declined to only 11 percent of total sales, the smallest export share since 1979. Inventories of four-wheel drive tractors increased to almost 1.5 years' supply of unsold stock.

Combines—Although combine sales in the first 3 months of 1983 were higher than for comparable 1982 months, subsequent sales were disappointing. Total sales for the first 8 months of 1983 were 20 percent lower than in 1982. Inventories almost remained unchanged with nearly a year's supply of unsold combines in dealers' or manufacturers' warehouses.

Other Machinery—Forage harvester sales in 1983 were slightly lower than in 1982 with a higher proportion exported. If typical seasonal sales patterns hold during the remainder of the year, forage harvester sales for 1983 are likely to drop 9 percent from 1982. Inventory levels for these machines improved somewhat, but nearly 18 months' supply was still on hand at midyear.

Domestic sales of balers increased in the first 8 months of 1983 compared with 1982, but exports fell. The net effect was a 1-percent decrease in net sales compared with a year earlier. Baler inventories improved significantly, but nearly a year's stock remained on hand in June 1983.

Mower conditioner sales were higher for every month of 1983 than for the same month in 1982, except for January. Inventories also improved, but a year's unsold stock was on hand at midyear.

Table 31.—Unit sales of selected farm machinery items, 1979-1983[1]

Year	Tractors		Self-propelled combines	Forage harvesters	Balers[3]	Mower conditioners
	2-wheel drive[2]	4-wheel drive				
			1,000 units			
Full Year						
1979	132.5	12.5	34.1	13.9	19.7	27.2
1980	115.2	12.6	28.4	10.9	15.8	21.4
1981	99.0	11.3	29.3	8.6	15.2	19.7
1982	73.5	8.2	18.3	5.7	9.9	14.6
January-August						
1982	51.2	5.8	9.4	3.4	8.2	11.9
1983	44.6	3.3	7.5	3.1	8.1	12.6
			Percent			
Change						
1979-82	−45	−34	−46	−59	−50	−46
1982-83	−13	−43	−20	−9	−1	+6

[1]Includes U.S. retail sales plus farm machinery manufactured in the United States or Canada and exported to any other country. Does not include farm machinery manufactured in Canada and sold there. [2]Includes two-wheel drive tractors 40 PTO horsepower and over. [3]Includes balers producing bales weighing under 200 pounds.

Sources: (3, 4).

Table 32.—Inventories: Weeks of selected farm machinery items, June 30 and Dec. 31, 1979-1983

Year	Inventories (sales requirements in weeks)											
	Tractors				Self-propelled combines		Forage harvesters		Balers		Mower conditioners	
	2-wheel drive		4-wheel drive									
	June	December	June	December	June	December	June	December	June	December	June	December
	Weeks											
1979	23	26	21	25	27	13	58	43	48	35	37	36
1980	33	29	29	31	29	22	68	55	62	45	55	51
1981	38	38	39	31	35	23	74	60	57	47	57	48
1982	53	47	40	34	52	39	101	82	74	61	67	60
1983	50	—	73	—	54	—	70	—	49	—	49	—

— = Not available.

Source: (4).

Local Dealer Closures

The recent slump in the farm equipment market took its toll on individual franchises. A reported 426 farm machinery dealerships closed in 1981 and 454 in 1982 (2). The high closure rate appears to be continuing in 1983.

According to a recent survey by the Farm Equipment Manufacturers Association, 188 dealers went out of business during the first 6 months of 1983. Since the survey did not cover the Midsouth, where closures were reported to be very high, this year's rate may be at least as high as in 1982. The recent decline is at least 2.5 times the historical annual closure rate of 2 percent.

Rising Prices and Net Cash Income

Declining machinery unit sales since 1979 were due mainly to rising machinery prices relative to other production items and low farm incomes. From 1979 through the first 9 months of 1983, overall machinery prices increased 45 percent, while prices for all production items rose only 23 percent (table 33). Between 1982 and 1983, machinery prices rose 7 percent while prices of production items increased 3 percent overall.

The price for two-wheel drive tractors both in the 50-59 horsepower and 110-129 horsepower categories increased about 40 percent from September 1979 to September 1983 (6). Prices for four-wheel drive tractors and self-propelled combines rose 37 percent and 39 percent, respectively, over the same period.

Farm machinery sales are considered largely a function of net farm income. While this is true, net farm income includes non-money elements (value of inventory changes, gross rental value of farm dwellings, and the value of home consumption). Net cash income (cash income minus cash expenses) is a better barometer of

farm machinery purchases, in that it includes only the actual money farmers have available for purchases.

Historically, farmers use surplus cash income to retire debt, buy feed, machinery, and other supplies, make investments, and repair buildings. From 1979 to 1982, prices received for all farm products increased less than 1 percent (6). For the same period, cash expenses exceeded cash income by approximately 6 percentage points. Consequently, net cash income decreased 3 percent from 1979 to 1982. Taking into account the 45-percent increase in machinery prices and the 23-percent rise in prices for all production items since 1979, the climate for machinery purchases was unfavorable. Nevertheless, cash expenses are expected to level off in 1983 and net cash income could increase to over $40 billion.

Future Prospects

The combination of reduced planted acreage, drought, and relatively high interest rates caused sales of most machinery items to continue to decline during the first 8 months of 1983. Based on a continuation of current sales trends and economic conditions, total unit sales for this year are expected to be substantially lower than last year for most items. Sales of mower conditioners, however, are expected to increase slightly.

The outlook for 1984 is somewhat brighter. Some forecasters project farm machinery unit sales will increase 10 to 15 percent. The key assumptions for next year include expectations of favorable commodity prices, coupled with only slight increases in production costs, a return to normal weather conditions, moderating interest rates, and increased field crop acreages. This should result in higher net farm income. Considering the long delays in machinery purchases and the pent-up demand, together with improved farm income prospects, farm machinery sales should improve.

Table 33.—Indexes of U.S. prices for machinery and all production items, 1979-1983 (1977=100)

Year	Machinery: Prices	Machinery: Change from previous year	All production items: Prices	All production items: Change from previous year
	Index	*Percent*	*Index*	*Percent*
1979	121		125	
		11		10
1980	134		138	
		11		7
1981	149		148	
		9		1
1982	163		149	
		7		3
1983[1]	175		154	
Percent change 1979-83	—	45	—	23

— = Not available.

[1]September 1983.

Source: (6).

ENERGY

Overview

The U.S. energy outlook for 1984 is encouraging, given the particularly volatile energy market conditions during the prior decade. Average 1984 nominal prices for gasoline, diesel fuel, and fuel oil are expected to change less than 1 percent relative to 1983 prices and decline in real terms (table 34). LP gas prices may rise 4 percent. Natural gas and electricity prices, however, are expected to rise 16 and 7 percent, respectively, relative to 1983 prices.

Because agriculture accounts for less than 3 percent of total U.S. energy consumption, energy prices paid by farmers are closely linked to domestic energy prices, which in turn are affected by world market forces and general domestic economic activity. While prices paid by individual farmers may differ from this outlook, percentage changes in projected energy prices between 1983 and 1984 provide useful comparisons.

In terms of availability, petroleum inventories are projected to amount to a 71.4 day supply (excluding the Strategic Petroleum Reserve) by the end of 1984. This should be more than adequate to prevent energy shortfalls during the peak planting and harvesting periods (7).

Some energy trends may stop or be reversed during 1984. Crude oil acquisition costs to refiners have declined since

Table 34.—Short-term U.S. energy prices (nominal)[1]

Product	Unit	1983 Quarter 1st	2nd	3rd	4th	1983 Year	1984 Quarter 1st	2nd	3rd	4th	1984 Year
						Cents					
Gasoline[2]	Gal.	117	123	127	125	123	126	126	124	120	124
Diesel fuel[3]	Gal.	110	104	106	107	107	107	108	109	110	108
LP gas[4]	Gal.	77	78	79	80	79	79	80	80	82	81
Electricity	Kwh.	6.8	7.2	7.6	7.2	7.2	7.2	7.8	8.0	7.6	7.7
Natural gas	Mil. Btu	338	344	377	392	363	410	422	427	433	423

[1]First and second quarter 1983 are actual prices, the remaining data are projections. [2]Average retail price for all grades including taxes. [3]Includes taxes. No. 2. heating oil prices are assumed to follow the same projections. [4]USDA estimates.

Source: (7).

1981. However, further reductions are not expected and the crude oil price per barrel (bbl.) should remain at about the August 1983 level of $29 per bbl. (7). For the U.S. economy, energy consumption per unit of output (real GNP) could increase for the first time since 1970. Total domestic energy consumption should reach about 74 quadrillion British thermal units (Btu), the highest level since 1979. This does not imply that energy conservation efforts have ceased, but that the estimated output effects produced by economic recovery and relatively modest energy price changes may limit incentives to conserve energy.

The continued decline in natural gas production and consumption since 1979 may be halted next year. During the first half of 1983, domestic gas production and consumption was 5 percent lower than the same period in 1982 and the lowest level since 1966. Expected 1984 production and consumption should increase about 7 percent over 1983 levels, given the scheduled increases in gas prices resulting from the Natural Gas Policy Act of 1978 and anticipated further economic recovery.

U.S. electricity consumption, which has been growing steadily since 1974, declined slightly in 1983. However, a modest rise is expected in 1984 due to anticipated increased economic activity.

The PIK program and the severe drought in 1983 distorted typical farm energy use patterns, making comparisons difficult. Direct and indirect energy use in farm production declined 17 percent from 1982 to 1983 (5). On-farm energy use and consequent energy expenditures are expected to rise substantially in 1984 relative to 1983, given preliminary planting projections.

Prices

Short-term U.S. energy price forecasts for 1984 are provided in table 34. Assumptions on which these forecasts are based include: a 4.8-percent GNP growth rate from 1983 to 1984, normal weather conditions, refiner acquisition crude oil costs of $29 per bbl., and an 8-percent increase in industrial production.

Changing the general economic and crude oil assumptions will, of course, produce different price projections. Using the alternative scenarios provided by the Department of Energy (7), a set of bounds may be constructed for these price projections. In the optimistic scenario, GNP is assumed to grow at a 5.7 percent rate compared with the 4.8-percent baseline and the crude oil price is assumed to decline to $25 per bbl. In the pessimistic scenario, GNP is assumed to be only 2.3 percent higher than in 1983 and crude oil prices rise to $32 per bbl. In the optimistic scenario, gasoline and diesel fuel prices decline to $1.12 and $0.96 per gallon, respectively. The natural gas price drops to $4 per million Btu and electricity to $0.074 per kilowatt-hour (kwh), compared with the respective $4.23 per million Btu and $0.077 per kwh base estimates. In the pessimistic scenario, gasoline, diesel, natural gas, and electricity prices rise to $1.29 per gallon, $1.13 per gallon, $4.46 per million Btu, and $0.08 per kwh, respectively. Given the uncertainty associated with the general domestic economic and crude oil assumptions, the actual 1984 prices may range 5 to 9 percent around the projections.

Agricultural Energy Supplies and Use

Supplies of energy to the agricultural sector are expected to be adequate to meet requirements for the remainder of 1983 and 1984. Two factors support this outlook. First, the U.S. petroleum demand and supply situation is much improved today compared with the 1973-80 period, primarily because of the significant reduction in reliance on petroleum imports. Second, supplies of imported crude oil are more dispersed than in the 1970's, with the bulk now coming from non-OPEC countries.

Domestic petroleum production is expected to decline slightly from 1983 to 1984, but overall supply will increase due to inventory drawdown and a slight rise in imports (including the Strategic Petroleum Reserve). Total petroleum product supplies are expected to rise 5 percent from 1983 levels. Natural gas supplies, given projected price increases, will advance from 1983 levels, as will electricity supplied to agricultural users.

Farm energy use per unit of output has been declining steadily since the mid-1970's as conservation tillage and energy efficient technologies are being adopted by farmers. The latest estimates of energy use per acre are included in table 35 for 1981, 1982, and projected for 1983. The 1983 estimates will likely be revised significantly as the effects of the drought are completely evaluated. It is likely that per-acre energy use may continue to decline, given the use of conservation tillage and other energy conserving practices.

Table 35.—Direct energy use estimates for U.S. crop production, 1981, 1982 and projected 1983

Product	1981	1982	Projected 1983[1]
Gasoline:			
Total use (Bil. gal.)	2.14	1.87	1.51
Per acre use (Gals.)	6.02	5.29	5.29
Per acre use (Mil. Btu's)	.75	.66	.66
Diesel:			
Total use (Bil. gals.)	2.42	2.48	2.08
Per acre use (Gals.)	6.79	7.02	7.02
Per acre use (Mil. Btu's)	.94	.97	.97
LP gas:			
Total use (Mil. gals.)	.68	.77	.62
Per acre use (Gals.)	1.90	2.17	2.17
Per acre use (Mil. Btu's)	.18	.21	.21
Fuel oil:			
Total use (Mil. gals.)	47.90	50.74	39.86
Per acre use (Gals.)	.13	.14	.14
Per acre use (Mil. Btu's)	.02	.02	.02
Natural gas:			
Total use (Bil. cu. ft.)	80.09	81.53	65.61
Per acre use (Cu. ft.)	225.15	230.45	230.45
Per acre use (Mil. Btu's)	.23	.23	.23
Electricity			
Total use (Bil. kwh)	20.58	18.54	14.92
Per acre use (Kwh)	57.85	52.40	52.40
Per acre use (Mil. Btu's)	.20	.18	.18
Total use (Trillion Btu's)	755.	724.	600.

[1]Per-acre harvested use assumed to be the same as 1982.

Sources: (1, 2, 3, 4, 5, 6).

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